FSI ANALYSIS OF ARTERY SUFFERING ATHEROSCLEROSIS

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For My Beloved Father,Mother,

Elder Sister, Elder Brother and Family.

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ABSTRACT

From the statistics of international death rates, United States shows 169.4 per 100,000 of population death in year 2005 because of coronary heart disease (CHD). An atheroma is an accumulation and swelling an artery walls that made up of (mostly) macrophage cells, or debris, that contain lipids (cholesterol and fatty acids), calcium and a variable amount of fibrous connective tissue. It results the artery wall thickens and hardens. This is called as atherosclerosis or "hardening of the arteries". Thus, will resulting in a heart attact and ensuing debility. In this project, a Fluid – Structure Interaction analysis is done on a blood flow in an artery which suffers atherosclerosis disease. The most often atherosclerotic plaque accumulate is at the abdominnal aorta. This analysis is done on a simplified model of abdominal aorta. The conditions to be analyze is regarding to the size and the stiffness of the atheroma. The software tools that using in this research is the ANSYS Workbench, with the coupling of ANSYS and CFX analysis. The output result of structural analysis of the abdominal aorta shows that the abdominal with the size of 15% atheroma shows the highest value of the Maximum Total Mesh Displacement and Von Mises Stress. While the result of fluid analysis of the blood flow in abdominal aorta shows that the increases of size and stiffness of atherma will increases the absolute gradient for the pressure and velocity of blood flow at the point 3 in analysis. However, the increases of absolute gradient of velocity and pressure of blood flow for the increases of atheroma stiffness is lower than the increases of absolute gradient of velocity and pressure of blood flow for the increases of atheroma size. Thus, the visualization of the interaction between blood flow and artery wall in the vicinity of atheroma will help medical researchers and doctor understand atherosclerosis better.

ABSTRAK

Daripada statistik kadar kematian antarabangsa, Amerika Syarikat menunjukkan 169,4 setiap 100,000 kematian penduduk dalam tahun 2005 kerana penyakit jantung koronari (CHD). Ateroma ialah pengumpulan dan bengkak di bahagian dinding arteri yang terdiri daripada sel-sel macrophage (kebanyakannya), atau serpihan yang mengandungi lipid (kolesterol dan asid lemak), kalsium dan jumlah tisu berlainan di perantara berserabut. Keadaan ini menyebabkan dinding arteri menebal dan mengeras. Kejadian ini dinamakan sebagai aterosklerosis atau pengerasan arteri ". Oleh itu, akan menyebabkan sakit jantung dan seterusnya menyebabkan kelesuan. Dalam projek ini, analisa Bendalir - Struktur Interaksi dilakukan ke atas aliran darah dalam arteri yang mengalami penyakit aterosklerosis. Plak atherosclerotic paling kerap terkumpul adalah pada aorta abdominnal. Oleh itu, analisis dilakukan ke atas model aorta abdomen yang dipermudahkan. Keadaan aorta abdomen yang akan dianalisis adalah mengenai saiz dan kekerasan ateroma. Alat-alat perisian yang digunakan dalam penyelidikan ini adalah ANSYS Workbench, dengan gandingan analisis ANSYS dan CFX. Hasil output analisis struktur aorta abdomen menunjukkan bahawa abdomen dengan saiz yang ateroma 15% menunjukkan nilai tertinggi dalam Jumlah Jejaring Pangalihan dan Tekanan Von Mises. Hasil analisis cecair aliran darah di dalam aorta abdomen menunjukkan bahawa peningkatan saiz dan kekerasan ateroma akan meningkatkan kecerunan mutlak bagi tekanan dan halaju aliran darah di titik 3 dalam analisis. Walau bagaimanapun, peningkatan kecarunan mutlak bagi halaju dan tekanan aliran darah untuk kenaikan kekerasan ateroma adalah lebih rendah daripada peningkatan kecerunan mutlak bagi halaju dan tekanan aliran darah untuk kenaikan saiz ateroma. Oleh itu, visualisasi interaksi antara aliran darah dan dinding arteri dengan adany ateroma akan membantu penyelidik perubatan dan doktor memahami aterosklerosis dengan lebih baik.

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LIST OF SYMBOLS AND ABBREVIATIONS

SYMBOL	DESCRIPTION
AA	Abdominal Aorta
ρ	Density
A	Cross sectional area
E	Young's Modulus of Elasticity
r	Radius
V	Volume
V	Velocity
t	Time
m	Meter
kg	Kilogram
s	Second (time)
π	Pai, the constant
a	acceleration
Pa	Pascal (pressure)
mmHg	Milimeter height of Mercury (pressure)
Cp	Specific heat capacity
μ	Viscosity
T	Temperature
K	Thermal conductivity
Q	Flow rate

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